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Invited essay

The effect of differential disgust conditioning and subsequent extinction versus counterconditioning procedures on women's sexual responses to erotic stimuli

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ABSTRACT

Recent theoretical accounts point to disgust as an important factor in the development and persistence of sexual dysfunctions. This study tested if (i) contingent disgust experiences can render initially sexually arousing stimuli disgusting, and (ii) such acquired disgust responses could be best neutralized via a CS-only extinction or a counterconditioning procedure. Participants (N = 74) were exposed to a differential conditioning procedure that was followed by either a CS-only extinction or a counterconditioning procedure. Erotic films served as the CS+/CS-. A disgusting film served as the US. During the extinction procedure, the CS+ was no longer followed by the disgusting US. During counterconditioning the CS+ was paired with positive stimuli. After conditioning, the CS + elicited lower genital arousal and was rated as significantly more disgusting, less pleasant, and less sexually arousing than the CS-. These diminished genital and subjective sexual arousal responses to the CS+ were successfully restored after both the extinction and the counterconditioning procedure, whereas conditioned feelings of disgust and behavioral avoidance persisted. There was no evidence for differential effectiveness of either procedure. Thus, sexual responses can be attenuated by learned sex-disgust associations and restored by extinction and counterconditioning procedures, but conditioned feelings of disgust seem more resistant.

1. Introduction

Female sexual dysfunctions are quite prevalent (American Psychiatric Association, 2013), with studies suggesting that approximately 40–45% of adult women suffer from at least one marked sexual dysfunction, such as lack of sexual interest, arousal, orgasmic or penetration disorder; approximately 22% of these women, report substantial personal distress due to their sexual problems (Shifren, Monz, Russo, & Segreti, 2008). Recent theoretical accounts point to the potential role of disgust in the etiology and persistence of female sexual dysfunction (Borg, Both, ter Kuile, & de Jong, 2020; de Jong, van Overveld, & Borg, 2013). Disgust is associated with strong negative feelings and the overwhelming urge to avoid or escape the disgust eliciting stimulus (Rozin & Fallon, 1987; Rozin, Nemeroff, Horowitz, Gordon, & Voet, 1995). Disgust eliciting stimuli seem to cluster in three domains: pathogen disgust (e.g., rotten food or bodily fluids), sexual disgust (e.g., potential sexual partner with unhealthy physical appearance), and moral disgust (e.g., 'improper' behavior) (Tybur, Lieberman, & Griskevicius, 2009). Stimuli from all of these domains can play a role in influencing sexual behavior, as in experienced repulsion in response to saliva or sperm, aversion toward specific physical features of the sexual partner, or disgust toward particular sexual behaviors due to ingrained restrictive sexual standards (de Jong et al., 2013). Disgust in sexual situations may undermine the sexual arousal response (e.g., Borg, Oosterwijk, Lisy, Boesveldt, & de Jong, 2019), result in disrupting defensive reflexes, and motivate sexual avoidance (de Jong et al., 2013). Accordingly, an association of higher disgust and lower sexual arousal has been observed in sexually healthy women (Andrews, Crone, Cholka, Cooper, & Bridges, 2015; Fleischman, Hamilton, Fessler, & Meston, 2015; Koukounas & McCabe, 1997). In addition, relatively strong sex-related disgust responses have been observed in women with vaginismus (Borg, de Jong, & Weijmar Schultz, 2010; van Overveld et al., 2013), and women with female sexual interest/arousal disorder, especially those with a history of sexual abuse,

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showed stronger disgust responses to erotic stimuli than healthy controls (DePesa & Cassisi, 2017). Relatedly, involuntary pelvic floor muscle contractions, shown to be a part of a general defensive reflex in response to sexual and non-sexual threat (i.e., film scenes depicting being bitten by a rabid dog and being sexually assaulted; van der Velde, Laan, & Everaerd, 2001), were also speculated to occur in response to disgusting stimuli (e.g., de Jong, van Overveld, Weijmar Schultz, Peters, & Buwalda, 2009). Furthermore, disgust is increasingly recognized as a common reaction in female sexual abuse victims, and this reaction may be associated with the development of post-traumatic stress disorder, and sexual dysfunction after sexual trauma (Badour & Feldner, 2016; Coyle, Karatzias, Summers, & Power, 2014). Taken together, these findings point to disgust as a relevant factor in female sexual dysfunctions, and indicate that strategies to reduce maladaptive disgust responses may be important in their treatment (Borg et al., 2020).

Associative learning experiences are proposed to play an important role in developing the ability of stimuli to elicit sexual appetite or sexual aversion (e.g., Brom, Both, Laan, Everaerd, & Spinhoven, 2014; Byrne, 1986; Hardy, 1964; Ågmo, 1999). Specifically, when sexual cues are repeatedly paired with negative emotional consequences such as disgust, appetitive sexual responses to these cues may weaken or even transform to aversive responses (Farmer et al., 2014; Ågmo, 2002). In disgust this was proposed to occur through a process of evaluative conditioning (Rozin, Millman, & Nemeroff, 1986), whereby the negative emotional consequences of disgust are proposed to be activated in response to sexual cues in turn eliciting behavioral inhibition and/or avoidance. In a similar vein, a series of differential aversive conditioning studies has shown that conditioned negative evaluations of sexual stimuli (induced by pairing these sexual stimuli with painful stimuli) are relatively resistant to extinction procedures, where the sexual stimuli were no longer followed by the painful US (Both et al., 2008; Brom, Laan, Everaerd, Spinhoven, & Both, 2015). Notably, disgust-induced evaluations seem especially resistant to extinction procedures with only conditioned stimulus presentations (i.e., CS-only extinction; e.g., Bosman, Borg, & de Jong, 2016; Engelhard, Leer, Lange, & Olatunji, 2014; Mason & Richardson, 2010; Olatunji, Forsyth, & Cherian, 2007). However, in spite of the proposed relevance and implications of disgust in sexual dysfunction, to date there are no studies directly testing how associative learning experiences impact on the learning or the extinction of disgust responses to sexual cues.

Therefore, the first aim of this study was to test if associative learning experiences have the potential to induce disgust toward initially sexually arousing cues across a variety of response systems. Consequently, we have included measures of physiological responses (i.e., genital arousal, pelvic floor and facial muscle activity), subjective responses (subjective sexual arousal, subjective disgust, and subjective affective valence), as well as behavioral responses (behavioral approach tendencies).

The second aim of this study, was to test if conditioned disgust responses toward initially sexually arousing (erotic) stimuli can again be reduced using an extinction procedure. Previous research has shown that although CS-only extinction procedures are effective in reducing learned US expectancies (e.g., if sexual stimuli then disgust stimuli will follow), such procedures are largely ineffective in modifying the acquired negative valence of the CS+ (e.g., Hermans, Crombez, Vansteenwegen, Baeyens, & Eelen, 2002). Subsequent research provided evidence indicating that for modifying (conditioned) affective responses, counterconditioning (CC) procedures seem more effective than CS-only extinction procedures (e.g., Kerkhof, Vansteenwegen, Baeyens, & Hermans, 2011). Furthermore, it has been argued that CC procedures might also be most effective in reducing (conditioned) disgust responses (de Jong, 2013). In line with this proposition, it has been shown that CC was effective in reducing acquired disgust toward originally neutral stimuli, whereas a similar reduction in conditioned disgust did not appear following a CS-only extinction procedure (Engelhard et al., 2014). However, this earlier study did not directly compare the efficacy of the CC procedure with a CS-only extinction procedure. To examine if CC could indeed be effectively applied to reduce conditioned disgust reponses to erotic stimuli, and to test the proposed effectiveness of CC compared to traditional CS-only extinction procedures, we included both types of procedures in the present design.

The current study used a differential conditioning paradigm, where one erotic film fragment (CS+) was consistently followed by a disgusting US, whereas another erotic film fragment (CS-) was consistently presented without the disgusting US. It was expected that through repeated pairing, the CS + would be learned to predict the disgusting US, and to instigate weaker sexual and stronger aversive responses. Following the acquisition procedure, one group of participants was subjected to a CS-only extinction procedure, where the CS+ was consistently presented without the US, while another group was subjected to a CC procedure, where the CS+ was repeatedly followed by pleasant pictures. Changes in US expectancy, genital sexual arousal (vaginal pulse amplitude; VPA), pelvic floor muscle activity, facial muscle activity, self-reported valence, sexual arousal, disgust and US expectancy ratings, as well as approach tendencies in response to the CS+ and the CS- were examined. *Following acquisition*, genital arousal, subjective valence, and sexual arousal ratings were expected to be lower in response to the CS + than in response to the CS-. At the same time, the US expectancy, pelvic floor activity, facial muscle activity, and subjective disgust were expected to be higher to the CS + than to the CS-. *Following the extinction or CC* procedure, both groups were expected to show reduced US expectancies. Only the CC group was expected to also show a return of the original sexual and affective responses to the CS+. In addition, it was expected that approach tendencies toward the CS + would be stronger following CC than following a CS-only extinction procedure.

2. Method

2.1. Participants and recruitment

Healthy pre-menopausal women were recruited through advertisements placed around the University campus (see Table 1 for sample characteristics). Participants were included if they were sexually active, and self-identified as heterosexual (due to the heterosexual nature of the stimulus material). Participants were excluded if they were pregnant, lactating, experienced sexual problems in the month prior to participation, were diagnosed with an affective or psychotic disorder,

Table 1
Sample characteristics.

Variable	Total		
	M (*SD*)/% of *N*	*N*	Range
Age (years)	25.20 (6.10)	74	19–46
In a relationship (%)	69.33%	52	N/A
Relationship duration (years)	3.33 (4.27)	52	0.20–25.30
Highest obtained degree (%)			N/A
Lower secondary	5.33%	4	
Higher secondary	33.33%	24	
College	18.67%	14	
University	42.67%	32	
Questionnaires			
FSFI (total score)	27.95 (5.75)	74	6–36
Disgust Propensity	24.31 (4.35)	74	10–27
Disgust Sensitivity	15.34 (4.54)	74	6–23
Sexual Excitation	2.96 (0.33)	74	2.04–3.96
Sexual Inhibition	2.31 (0.42)	74	1.15–3.54
SDQ Willingness	22.86 (8.21)	74	1–44
SDQ Willingness Familiar	16.55 (4.60)	74	1–24
SDQ Willingness Unfamiliar	6.31 (4.83)	74	0–20
SDQ Disgust	23.53 (8.18)	74	4–43
SDQ Disgust Familiar	7.89 (4.60)	74	0–19
SDQ Disgust Unfamiliar	15.64 (5.18)	74	3–24

abused drugs, suffered from a medical illness or used medication that could interfere with their sexual response. Before participation, all women received an information brochure including a description of the genital response measurement procedure. Participants received monetary compensation (i.e., €45 each), and were reimbursed for travel expenses. The study was approved by the Medical Ethics Committee of the University Medical Center (code P17.039).

2.2. Power and sample size

Taking evidence from previous studies into account (e.g., Both et al., 2008) and a power calculation (α = 0.05, power = 0.80, d = 0.50) performed using G*Power program (Faul, Erdfelder, Lang, & Buchner, 2007) adjusted to "as in SPSS", it was established that a minimum number of participants needed to obtain meaningful results in a mixed ANOVA with two groups and four repeated measurements was 31 per group. The current sample of N = 74 fulfilled this criterion, with n = 34 in CC group and n = 40 in the extinction group.

2.3. Materials and measures

2.3.1. Stimuli

A 3-min nature documentary served as a neutral stimulus during the resting baseline measurements. Two different fragments of female-friendly erotic films depicting heterosexual vaginal intercourse served as the CSs. Which fragment served as the CS + or the CS- was counterbalanced across participants. Each of the CSs was presented for 8 s on each trial. A disgust-inducing 40-s film clip of a woman throwing up that has been successfully applied in previous research (Borg et al., 2010; de Jong, Peters, & Vanderhallen, 2002), was divided into eight 5-s fragments. Each of these fragments served as a disgusting US and followed the CS + presentation during acquisition trials. A 40-s excerpt of a neutral documentary on hand-made glass that has also been used in previous research (Borg et al., 2010), was divided into 5-s fragments. Each of these fragments followed a presentation of the CS- during acquisition trials, as a neutral US. Positive stimuli that consistently followed the CS+ during CC phase comprised of three categories of pictures with high positive valence (i.e., 5 pictures of romantic couples; 5 pictures of palatable food; 5 pictures of puppies, babies and young animals), and were derived from the International Picture System (Lang, Bradley, & Cuthbert, 1998; IAPS picture numbers: 1440, 1710, 2040, 2050, 2260, 2530, 2550, 4610, 4622, 4626, 7200, 7230, 7270, 7325, 7330). Each of the positive stimuli was presented for 8 s following a CS + trial.

2.3.2. Physiological measurements

To index genital arousal, vaginal pulse amplitude (VPA) was measured using a vaginal photoplethysmograph (Laan, Everaerd, van Bellen, & Hanewald, 1994). Pelvic floor muscle activity was measured using two electromyography (EMG) electrodes fixed on the vaginal photoplethysmograph (Both, van Lunsen, Weijenborg, & Laan, 2012). Facial muscle activity was measured with two pairs of EMG electrodes, placed on the right side of the face on the *levator alesque nasii* muscle (unique marker of disgust response; Borg, Bosman, Engelhard, Olatunji, & de Jong, 2016) and on the *corrugator supercilii* muscle (index of general negative affect; Borg et al., 2016). Indices of genital arousal, activity of pelvic floor and facial muscles were sampled continuously during baseline, preconditioning, acquisition, and extinction/CC phases.

2.3.3. Subjective ratings

To index valence, sexual arousal, and disgust in response to the CSs, participants rated their experiences during the CS+ and the CS- presentations on those dimensions on 7-point Likert scales (*1 = Extremely unpleasant – 7 = Extremely pleasant* for valence; *1 = Not sexually arousing at all – 7 = Extremely sexually arousing* for sexual arousal; and *1 = Not disgusting at all – 7 = Extremely disgusting* for disgust). The US expectancy was indexed using participant ratings of the extent to which they expected each of the CSs to be followed by the disgust inducing US on a 7-point Likert scale (*1 = Certainly not followed by a disgusting movie – 7 = Certainly followed by a disgusting movie*). Additionally, participants rated the valence and disgust potency of each of the USs and of the CC stimuli using a 7-point Likert scale (*1 = Extremely unpleasant – 7 = Extremely pleasant* for valence; *1 = Not at all disgusting – 7 = Extremely disgusting* for disgust).

2.3.4. Behavioral Approach Task

Approach tendencies were assessed by asking participants to indicate their willingness to watch a longer film clip that included the CS +, and a film clip that included the CS-, on a 7-point Likert scale (*1 = Not at all willing – 7 = Very much willing*), and to choose which of the two film clips they preferred to watch.

2.3.5. Questionnaire data

2.3.5.1. Demographic questionnaire. Information on participant demographic variables such as age, educational level, and relationship characteristics was obtained with a short questionnaire.

2.3.5.2. The female sexual function index (FSFI; Rosen et al., 2000). The FSFI is a 19-item self-report questionnaire assessing sexual function in women. Items focus on issues with sexual desire, arousal, lubrication, orgasm, satisfaction, and pain. The FSFI has good psychometric properties in a Dutch population (ter Kuile, Brauer, & Laan, 2006). In the current sample the subscales of the FSFI had satisfactory to excellent internal consistency (α range 0.73–0.96), while the full scale was shown to have high internal consistency (α = 0.94).

2.3.5.3. The disgust propensity and sensitivity scale revised (DPSS-R; van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006). The DPSS-R is a 12-item self-report questionnaire that measures disgust propensity (i.e., the frequency of disgust experiences) with items such as "I experience disgust", and disgust sensitivity (i.e., the emotional impact of those disgust experiences) with items such as "I think feeling disgust is bad for me" on a 5-point Likert scale (*1 = Never – 5 = Always*). The subscales have been shown to have satisfactory psychometric properties in Dutch population (van Overveld et al., 2006). In the current sample the subscales of disgust propensity and sensitivity had a satisfactory internal consistency (α = 0.71 and α = 0.74, respectively).

2.3.5.4. The sexual excitation/sexual inhibition inventory for women (SESII-W; Graham, Sanders, & Milhausen, 2006). The SESII-W is a 36-item self-report questionnaire assessing participants' propensity for sexual excitation and sexual inhibition using a 4-point Likert scale (*1 = Strongly Disagree – 4 = Strongly Agree*). The SESII-W was shown to have satisfactory psychometric properties in a Dutch population (Bloemendaal & Laan, 2015). The internal consistency of the SE scale in the current sample was established to be good (α = 0.81), and the same was true for the internal consistency of the SI scale (α = 0.81).

2.3.5.5. The sexual disgust questionnaire (SDQ; van Overveld et al., 2013). The SDQ is a 12-item self-report questionnaire that measures two scales: willingness to handle sexually contaminated items (SDQ-W), and the experience of disgust toward these sexually contaminated items (SDQ-D) using a 9-point Likert scale (*0 = Certainly not willing – 8 = Certainly willing* for the SDQ-W and *0 = Not at all disgusting – 8 = Extremely disgusting* for the SDQ-D). Both the SDQ-W and the SDQ-D have two subscales each. The subscales are derived from two types of contamination sources, distinguishing sources of familiar (i.e., oneself or a partner) and unfamiliar origin (i.e., a stranger), thus constituting Familiar and Unfamiliar subscales of each scale. The SDQ has good convergent validity and has been shown to have satisfactory properties in a Dutch population (van Overveld et al., 2013). The SDQ-W and the

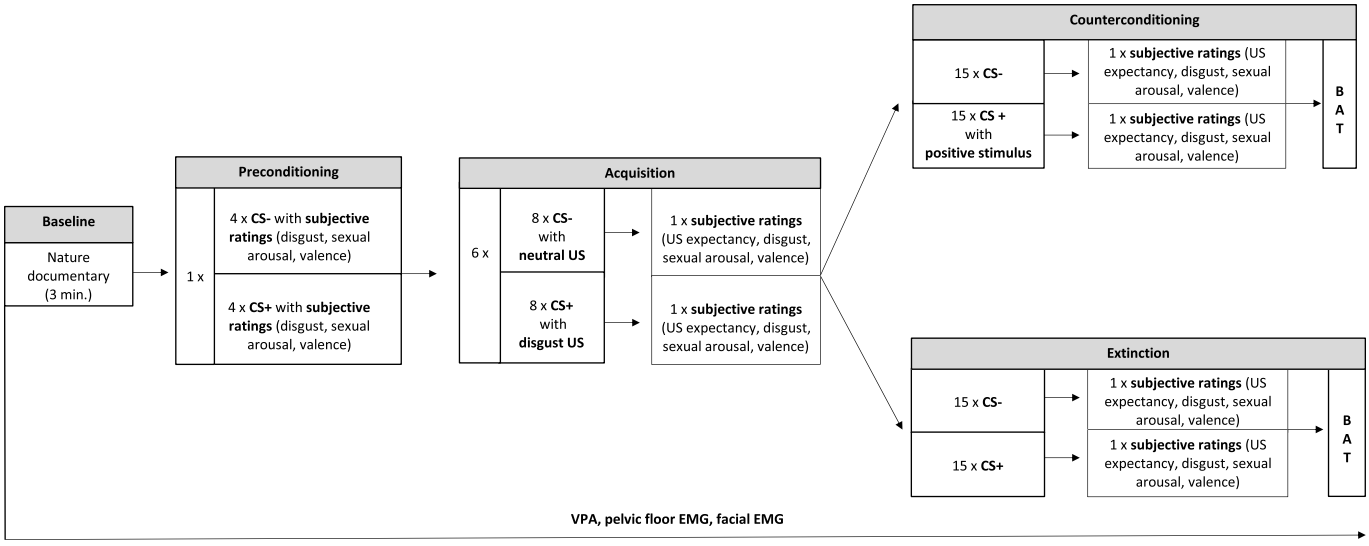


Fig. 1. A flowchart illustrating phases of the experiment in order of presentation.

SDQ-D had satisfactory internal consistency in the current sample ($\alpha = 0.73$ and $\alpha = 0.70$, respectively), as did the Familiar subscales of the SDQ-W and of the SDQ-D ($\alpha = 0.76$ and $\alpha = 0.68$, respectively). However, the Unfamiliar subscales of the SDQ-W and the SDQ-D had poor internal consistency ($\alpha = 0.50$ and $\alpha = 0.58$, respectively). After removal of two items 5 and 11 ("*Use a towel for your face that has been thoroughly cleaned after it has been used following sexual intercourse to wipe off sperm/vaginal fluids of an unknown person (e.g., a towel in a hotel)*"), which had the lowest correlation with the other scale items in each of the subscales, the internal consistency of the Unfamiliar subscales of the SDQ-W and the SDQ-D increased to satisfactory ($\alpha = 0.77$ and $\alpha = 0.80$, respectively).

2.4. Procedure

Eligible volunteers were randomly allocated to the CS-only extinction or the CC condition and were invited for a individual experimental session that lasted approximately 1.5–2 h. A trained female experimenter informed participants that the purpose of the study was to measure physiological and psychological responses to erotic and disgusting stimuli. The experimenter described the physiological and subjective measures in detail. Participants were then invited to sign the informed consent form. After that, in private, participants completed a series of questionnaires, including the demographic questionnaire, the SESII-W, the FSFI, the DPSS-R, and the SDQ. Following, participants were led to the participant room where they were left alone to privately insert the vaginal probe used to measure genital arousal and pelvic floor activity. Upon participant's signal through an intercom that the probe was in place and that they were seated comfortably, the experimenter re-entered the room and applied the facial EMG electrodes, after which she left the room. Further instructions were given exclusively through an intercom and via written instructions displayed on a screen connected to one of the computers in the experimenter room. After a 3-min resting baseline period, during which participants watched a short excerpt of a nature documentary while the baseline physiological measurements were collected, the preconditioning, acquisition, and extinction or CC phases followed. The preconditioning phase consisted of four presentations of the CS + and four presentations of the CS-, in a semi-random order with the restriction of a maximum of two successive presentations of each CS. During the preconditioning phase participants rated valence, sexual arousal, and disgust in response to the CS + and the CS- following each stimulus presentation. The acquisition phase consisted of six blocks of eight presentations of the CS + paired with the disgusting US and six blocks of eight presentations of the CS- paired with the neutral US. The blocks were shown in a semi-random order with the restriction of a maximum of two successive presentations of each block. Participants rated valence, sexual arousal, disgust and US expectancy in response to the CS + and the CS- once after the acquisition phase. For participants assigned to the extinction procedure, the extinction phase consisted of 15 presentations of solely the CS +, and 15 presentations of solely the CS-, in a semi-random order with the restriction of a maximum of two successive presentations of each CS. For participants assigned to the CC procedure, the CC phase consisted of 15 presentations of the CS +, each followed by a positive stimulus presentation, and 15 presentations of solely the CS-, in a semi-random order with the restriction of a maximum of two successive presentations of each CS. Following the extinction or CC procedure, participants rated valence, sexual arousal, disgust, and US expectancy in response to the CS + and the CS- once. After that participants completed the Behavioral Approach Task. Having indicated their film clip preference, participants were informed that it was not necessary to actually watch the film. All subjective ratings as well as the Behavioral Approach Task were completed using buttons 1 through 7 on a 10-digit response box. Lastly, participants rated the valence and disgust potency of each of the USs and of the CC stimuli. During each phase, intertrial intervals varied between 20 and 25s. After completion of the experimental task, participants completed an exit questionnaire in which they were asked about their subjective appreciation of the experimental procedure and the use of the genital measurement device. Fig. 1 shows the experimental procedure.

2.5. Data reduction and analysis

Due to a technical failure of the facial EMG measurements, results of the analyses involving measures of facial muscle activity were not reported. Due to a malfunction of the measurement device, the responses of 22 out of the 74 participants were missing for the pelvic floor activity measures, and the responses of 5 out of the 74 participants were missing for the genital arousal measures. Indices of sample characteristics were computed using frequency and descriptive statistics yielding means, sum scores and standard deviations. For each of the subjective responses in the preconditioning phase, mean subjective response has been calculated over the four CS presentations resulting in one data point for the CS + and one data point for the CS-. One data point for the CS + and one data point for the CS- were derived for each of the subjective responses post-acquisition. Similarly, one data point for the CS +

Table 2
Subjective ratings of pleasantness and disgust in response to disgust US, neutral US, C-CS 1, C-CS 2, and C-CS 3.

Stimulus	Pleasantness	Range	Disgust	Range
	M *(SD)*		M *(SD)*	
Disgust US	1.66 (1.11)	1–7	6.35 (1.00)	3–7
Neutral US	4.77 (0.99)	3–7	1.11 (0.54)	1–4
CCS 1	5.38 (1.10)	4–7	1.35 (0.81)	1–4
CCS 2	5.18 (1.22)	3–7	1.44 (0.89)	1–4
CCS 3	5.09 (1.44)	2–7	1.82 (1.69)	1–7

Note. US = unconditioned stimulus; USs were rated by the full sample; CCS = Positive counterconditioning stimulus; CCSs were rated only by participants in the counterconditioning Condition; CCS 1 = pictures of romantic couples; CCS 2 = pictures of food; CCS 3 = pictures of puppies, babies and young animals.

and one data point for the CS- were derived for each of the subjective responses post-extinction or post-CC.

For each of the physiological responses, mean change scores have been calculated by subtracting mean physiological response during baseline from the mean physiological response during CS+ and CS- presentations. Subsequently, a mean change score was calculated for the CS+ and the CS- in the preconditioning phase, resulting in one data point for the CS+ and one data point for the CS-. For the acquisition phase a mean CS + change score and a mean CS- change score was calculated for each block, resulting in six data points for the CS+ and six for the CS-. For the extinction or CC phase, a mean CS + change score, and a mean CS- difference change score was calculated over 5 trials, resulting in three data points for the CS + as well as for the CS-. In addition, for the pelvic floor EMG, change scores were calculated for responses to the USs by substracting the response during baseline from the response during the disgusting US or the neutral US, resulting in six data points for the disgusting US and 6 data points for the neutral US. For the physiological responses, post-acquisition was operationalized as mean responding during the last acquisition block, while post-extinction and post-CC were operationalized as mean responding during the last 5 trials of the extinction/CC phase.

To verify whether the film clips that served as the disgusting US and the neutral US worked as intended, as well as to check for any potential group differences, 2 (Stimulus: Neutral US vs. Disgusting US) x 2 (Condition: Extinction vs. CC) mixed ANOVAs were used on the valence and disgust responses to the USs. To check whether pelvic floor activity is indicative of a disgust defense reflex and whether that effect differed between the groups, mean pelvic floor muscle activity during the acquisition phase in response to each of the USs was examined using a 2 (Stimulus: Neutral US vs. Disgusting US) x 6 (Acquisition Block) x 2 (Condition: Extinction vs. CC) mixed ANOVA. The ratings of the positive stimuli used during the CC procedure were evaluated using statistics yielding means and standard deviations. To evaluate the effect of the conditioning procedure, genital arousal, pelvic floor muscle activity, and subjective responses to the CS+ and the CS- during the preconditioning and post-acquisition were analyzed. Differential conditioning effects and potential group differences were tested with 2 (Stimulus: CS + vs. CS-) x 2 (Phase: Preconditioning vs. Post-acquisition) x 2 (Condition: Extinction vs. CC) mixed ANOVAs, and paired comparisons were used to further test differential responding to the CS+ and the CS- post-acquisition. Extinction and CC effects were evaluated using 2 (Stimulus: CS + vs. CS-) x 2 (Phase: Post-acquisition vs. Post-extinction/CC) x 2 (Condition: Extinction vs. CC) mixed ANOVAs. Paired comparisons were used to further examine the responses to the CS+ and the CS- post-extinction/CC. With regard to approach tendencies, willingness to watch the film including the CS+ and the film including the CS- were analyzed using a 2 (Stimulus: CS + vs. CS-) x 2 (Condition: Extinction vs. CC) mixed ANOVA. A *z*-test was used to determine whether there was a difference between the percentage of participants who preferred to watch the film including CS+ and the percentage of participants who preferred to watch the film including CS-, and whether that differed between the conditions. Greenhouse-Geisser correction was used where the sphericity assumption was violated. Effect sizes were reported as Cohen's *d*, where $d = 0.2$ indicated a small, $d = 0.5$ a medium, and $d = 0.8$ a large effect.

3. Results

3.1. Sample characteristics

Table 1 shows a summary of all relevant sample characteristics, including questionnaire scores. All mean questionnaire scores in the current sample were within the normal range (cf. Bloemendaal & Laan, 2015; Fergus & Valentiner, 2009; van Overveld et al., 2013; Wiegel, Meston, & Rosen, 2005).

3.2. Preconditioning analyses and manipulation check

Unexpectedly, analyses indicated that the CS + elicited more genital arousal than the CS- during the preconditioning phase, $F(1,66) = 4.70$, $p = .034$, $d = 0.55$. No significant differences were found between the CS+ and CS- with regard to pelvic floor muscle activity, and any of the subjective ratings during the preconditioning phase (all *ps* > .070). Moreover, responses to the stimuli during the preconditioning phase did not differ between the extinction and CC groups (all *ps* > .140).

3.3. Evaluation of the US and the CC stimuli

Table 2 shows the subjective ratings of valence and disgust in response to each of the USs, as well as in response to each of the three types of positive stimuli used during CC. Regarding the disgust potency of the disgusting US, ratings showed that the majority of the participants experienced the clip as disgusting and unpleasant, while the neutral US was generally perceived as pleasant and not disgusting. The disgusting US was rated as far more disgusting $F(1,72) = 1620.58$, $p < .001$, $d = 9.79$, and as far less pleasant, $F(1,72) = 310.84$, $p < .001$, $d = 4.13$, than the neutral US. These ratings did not differ between groups (all *ps* > .08). Overall, the positive stimuli used during CC procedure were rated as fairly pleasant.

3.4. Effect of the US on pelvic floor muscle activity

There was a significant main effect of Stimulus on pelvic floor muscle activity during the acquisition phase, $F(1,51) = 7.72$, $p = .008$, $d = 0.77$. In line with expectations, pelvic floor muscle activity was higher in response to the disgust stimulus compared to the neutral stimulus. The effect of the USs on pelvic floor muscle activity did not differ between conditions, as evidenced by a non-significant Stimulus x Condition interaction effect, $F(1,51) = 0.26$, $p = .611$.

3.5. Differential conditioning effects

3.5.1. VPA and pelvic floor muscle activity

Fig. 2 shows mean VPA in response to the CS+ and the CS- during the preconditioning phase and each block of the acquisition phase. VPA data showed a significant Stimulus x Phase interaction, $F(1,66) = 9.01$, $p = .004$, $d = 0.74$, indicating that the conditioning procedure resulted in a relative decrease in arousal eliciting properties of the CS + compared to the CS-. This conditioning effect did not differ between conditions, as evidenced by a non-significant Stimulus, x Phase x Condition interaction, $F(1,66) = 0.08$, $p = .783$. The analysis of the pelvic floor muscle activity revealed no significant Stimulus x Phase interaction, $F(1,49) = 0.20$, $p = .661$, or Stimulus x Phase x Condition interaction, $F(1,49) = 0.88$, $p = .352$, indicating a general lack of conditioning effect across both conditions.

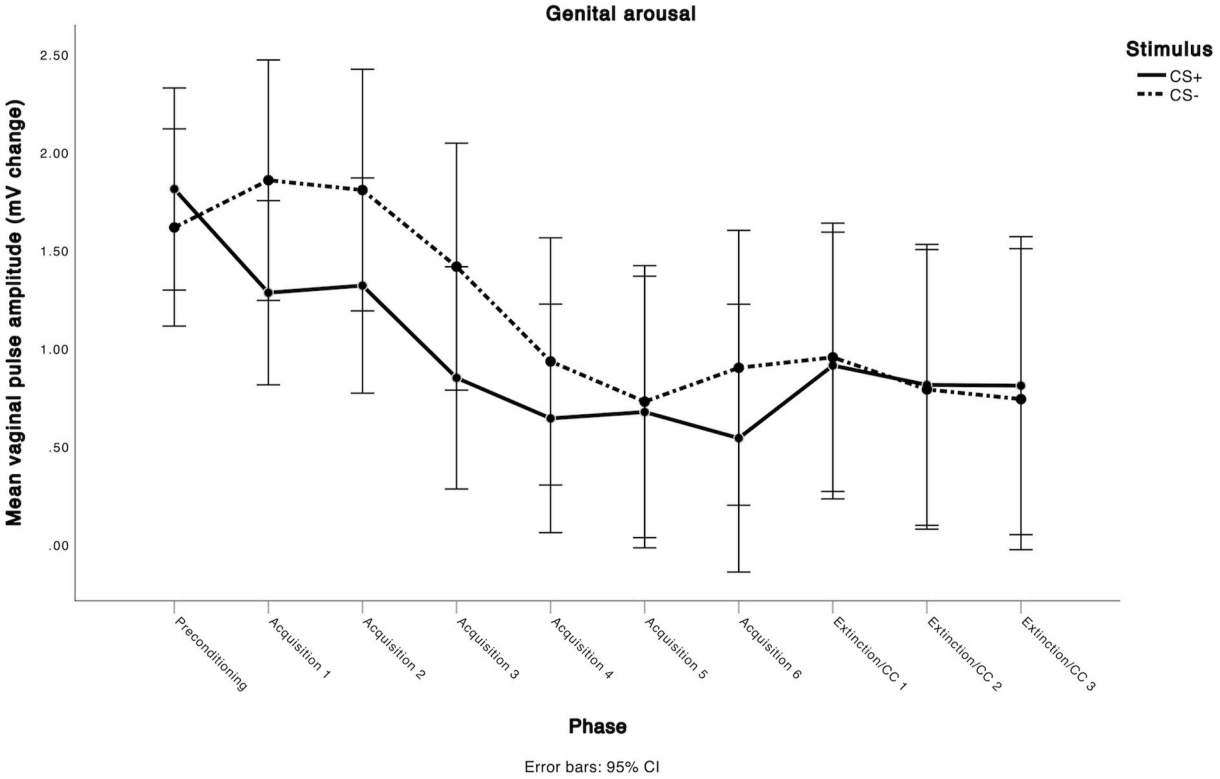


Fig. 2. Genital arousal responses to the CS+ and the CS- across the phases of the experiment.

3.5.2. Ratings of US expectancy, disgust, sexual arousal, and valence

Figs. 3–5 show subjective ratings of disgust, sexual arousal, and valence in response to CS+ and CS- during preconditioning and post-acquisition. Fig. 6 shows subjective ratings of US expectancy post-acquisition. Post-acquisition, US expectancy ratings were significantly higher in response to the CS + compared to the CS-, $t(72) = 8.98$, $p < .001$, $d = 1.04$. Thus, the conditioning procedure successfully elicited differential US expectancies. As indicated by significant Stimulus x Phase interactions, there were significant and substantial differences in ratings of disgust, $F(1,70) = 33.52$, $p < .001$, $d = 1.38$, sexual arousal, $F(1,70) = 34.13$, $p < .001$, $d = 1.39$, and valence, $F(1,70) = 21.48$, $p < .001$, $d = 1.11$, in response to the CS+ and the CS- from preconditioning to post-acquisition. Subsequent *t*-tests showed that post-acquisition, participants evaluated the CS + as more disgusting, $t(72) = 6.41$, $p < .001$, $d = 0.75$, less sexually arousing, $t(72) = 5.72$, $p < .001$, $d = 0.66$, and less pleasant, $t(72) = 5.04$, $p < .001$, $d = 0.59$, than the CS-. These conditioning effects did not differ between conditions (all *ps* > .190).

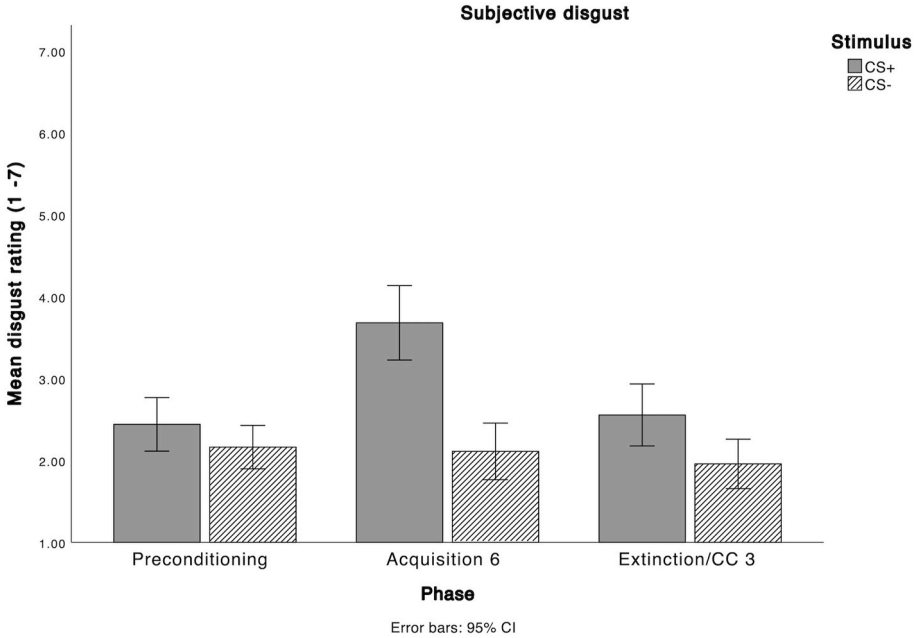


Fig. 3. Ratings of subjective disgust in response to the CS+ and the CS- in each phase of the experiment.

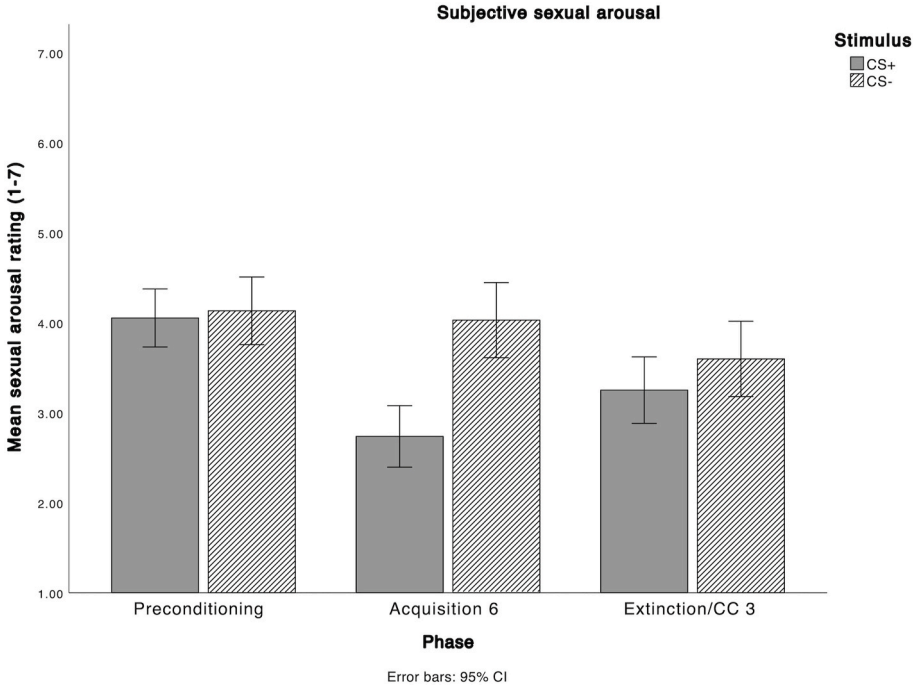


Fig. 4. Ratings of subjective sexual arousal in response to the CS+ and the CS- in each phase of the experiment.

3.6. *Extinction and CC effects*

To evaluate the effectiveness of extinction and CC procedures on extinguishing conditioning effects, responses to the CS+ and the CS- from post-acquisition to post-extinction/CC were analyzed. As no conditioning effects were found for the pelvic floor muscle activity, these responses were not analyzed any further.

3.6.1. *VPA*

Fig. 2 shows the pattern of genital responses to the CS+ and the CS- post-acquisition and post-extinction/CC. Analysis of genital responses to the stimuli revealed a significant Stimulus x Phase interaction, $F(1,64) = 6.32$, $p = .014$, $d = 0.63$, but no significant Stimulus x Phase x Condition interaction, $F(1,64) = 0.26$, $p = .615$. Subsequent paired samples *t*-tests showed no significant increase in genital responses from post-acquisition to post-extinction/CC in response to the CS+, $t(65) = 1.29$, $p = .202$, nor in response to the CS-, $t(66) = 0.94$, $p = .353$. Nonetheless, post-extinction/CC genital responses to the CS+ and the CS- did not differ significantly, $t(65) = 0.83$, $p = .410$. This indicated that although no significant increase in genital response to the

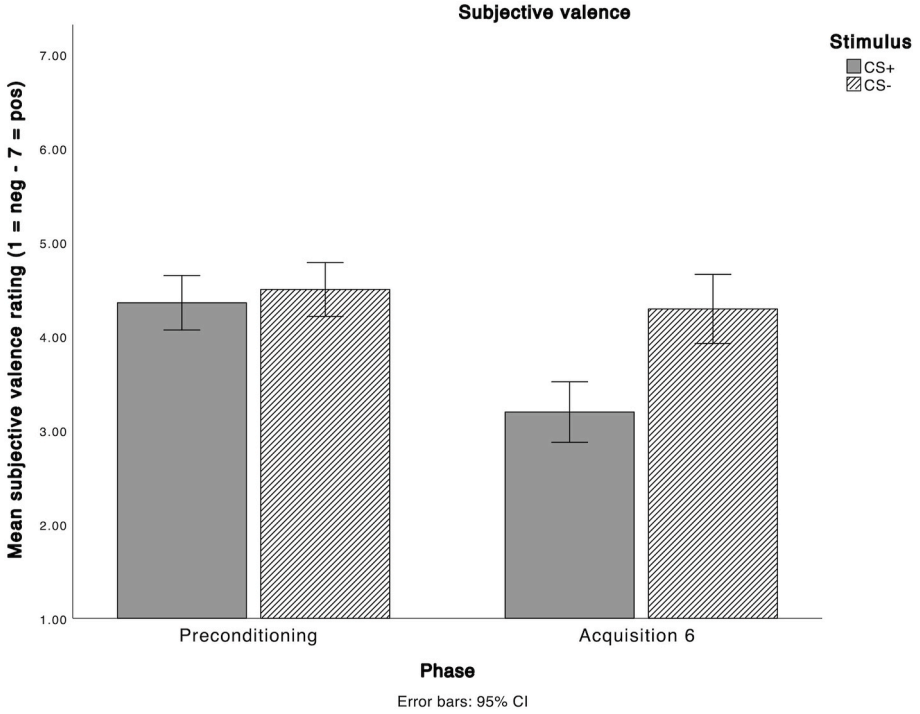


Fig. 5. Ratings of subjective disgust in response to the CS+ and the CS- during the preconditioning phase and post-acquisition.

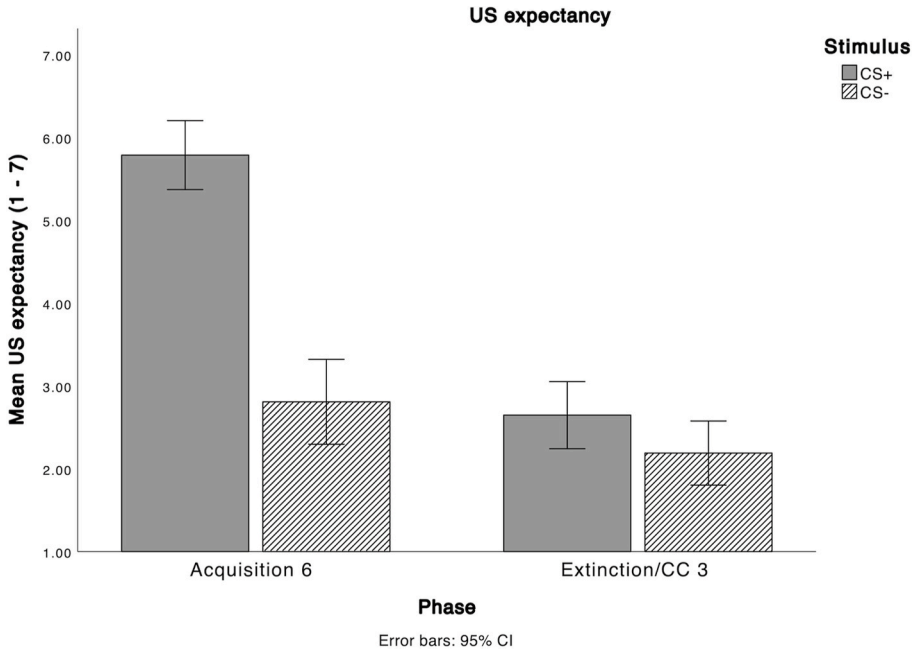


Fig. 6. US expectancy ratings post-acquisition and post-extinction/CC.

CS+ was found following extinction and CC procedures, genital responses to the CS+ and CS- did no longer differ after these procedures.

3.6.2. Ratings of US expectancy, disgust, sexual arousal, and valence

Fig. 6 illustrates US expectancy ratings in response to the CS+ and the CS- post-acquisition and post-extinction/CC. Analysis of US expectancy ratings in response to the stimuli showed a significant Stimulus x Phase interaction, $F(1,71) = 7.71$, $p = .007$, $d = 0.66$, but no Stimulus x Phase x Condition interaction, $F(1,71) = 0.13$, $p = .724$, indicating that the heightened US expectancy for the CS + decreased to a similar extent in both conditions. Indeed, paired samples *t*-tests revealed a significant decrease in US expectancy from post-acquisition to post-extinction/CC in response to the CS+, $t(72) = 10.75$, $p < .001$, $d = 1.25$, but also in response to the CS-, $t(72) = 2.69$, $p = .009$, $d = 0.30$, although to a much smaller extent. Moreover, paired samples *t*-tests revealed no significant differences between expectancy ratings in response to the CS+ and the CS- post-extinction/CC, $t(73) = 1.80$, $p = .076$, indicating that participants have successfully 'unlearned' the association between the CS+ and the disgusting US.

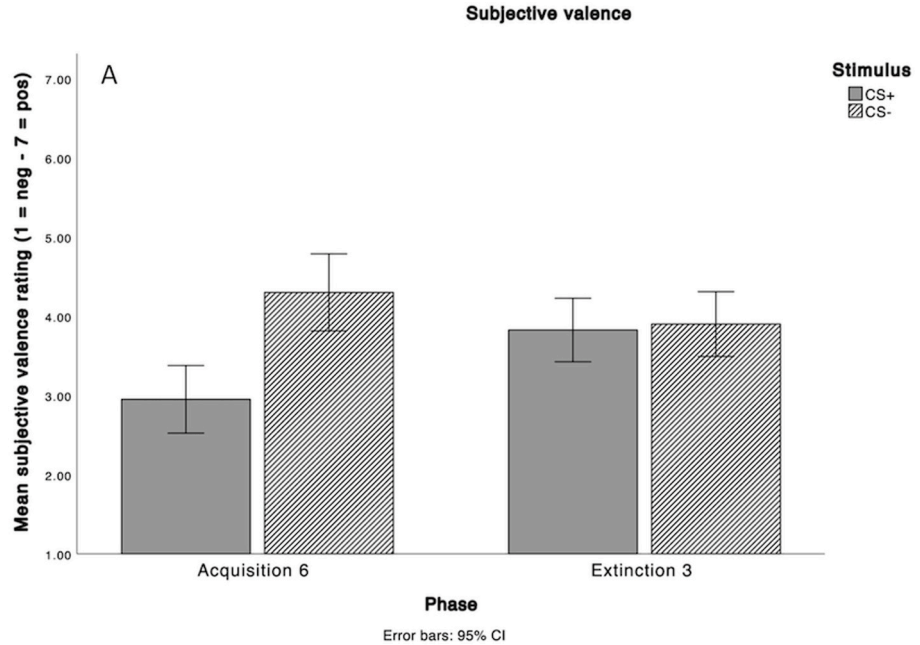
Fig. 3 shows the mean ratings of disgust in response to the CS+ and the CS- post-acquisition and post-extinction/CC. Analysis of disgust ratings in response to the CSs showed a significant Stimulus x Phase interaction, $F(1,71) = 22.02$, $p < .001$, $d = 1.12$, but no significant Stimulus x Phase x Condition interaction, $F(1,71) < 0.01$, $p = .962$. Paired samples *t*-tests indicated that for both conditions disgust to the CS + showed a decline, $t(72) = 5.79$, $p < .001$, $d = 0.67$, whereas the disgust eliciting properties of the CS- remained largely unaffected, $t(72) = 1.17$, $p = .246$. Nonetheless, paired samples *t*-tests also revealed that the CS+ was rated as significantly more disgusting than the CS- post-extinction/CC, $t(73) = 3.78$, $p < .001$, $d = 0.45$. Thus, even though both methods seemed to be effective in decreasing conditioned subjective disgust, they were not effective in complete extinction.

Fig. 4 shows the mean ratings of sexual arousal in response to the CS + and the CS- post-acquisition and post-extinction/CC. Analysis of sexual arousal ratings showed a significant Stimulus x Phase interaction, $F(1,71) = 21.94$, $p < .001$, $d = 1.12$. However, no significant Stimulus x Phase x Condition interaction was found, $F(1,71) = 0.30$, $p = .862$, indicating that both methods affected the change in subjective sexual arousal in response to the CS+ and the CS- in a similar way. Specifically, paired samples *t*-tests revealed that sexual arousal ratings in response to the CS + significantly increased from post-acquisition to post-extinction/CC, $t(72) = 3.38$, $p = .001$, $d = 0.39$, while sexual arousal ratings in response to the CS- decreased significantly, $t(72) = 2.91$, $p = .005$, $d = 0.34$. Nevertheless, paired samples *t*-tests also revealed a small statistical trend for the CS + to be rated as less sexually arousing than the CS- post-extinction/CC, $t(73) = 1.99$, $p = .051$, $d = 0.23$. Thus, despite the negative effects of the extinction/CC procedures on subjective sexual arousal in response to the CS- and the positive effects on subjective sexual arousal in response to the CS+, the CS+ was still rated as less sexually arousing than the CS-.

Panels A and B of Fig. 7 show the mean valence ratings in response to the CS+ and the CS- post-acquisition and post-extinction, as well as post-acquisition and post-CC, respectively. Analysis of valence ratings in response to the CSs showed a significant Stimulus x Phase x Condition interaction, $F(1,71) = 4.84$, $p = .031$, $d = 0.51$. Thus, the differential change in valence of the CS+ and the CS- varied between conditions. Paired samples *t*-tests indicated there was a significant increase in valence ratings in response to the CS+ from post-acquisition to post-extinction, $t(39) = 4.38$, $p < .001$, $d = 0.69$, and from post-acquisition to post-CC, $t(32) = 3.54$, $p = .001$, $d = 0.61$. However, there was also a trend toward a decrease in valence ratings in response to the CS- from post-acquisition to post-extinction, $t(39) = 1.89$, $p = .066$, $d = 0.30$, but not from post-acquisition to post-CC, $t(32) = 1.28$, $p = .209$. This indicates an increase in valence of the CS+ and a decrease of the valence of the CS- in the extinction condition, but not in the CC condition, where only valence of the CS + has increased, without having much effect on the valence of the CS-. Furthermore, paired samples *t*-tests revealed that there was no significant difference in valence ratings between the CS+ and the CS- post-extinction, $t(39) = 0.28$, $p = .780$. However, post-CC subjective valence ratings in response to the CS+ and the CS- were significantly different, $t(32) = 2.73$, $p = .010$, with higher valence ratings in response to the CS-. Thus, while the CS+ and the CS- were rated as equally pleasant post-extinction, post-CC the CS- was rated as more pleasant than the CS+.

3.7. Behavioral approach task

Analysis of the approach-avoidance tendencies revealed a significant Stimulus effect, $F(1,72) = 6.37$, $p = .014$, $d = 0.60$, but showed no significant Stimulus x Condition interaction, $F(1,72) = 2.20$,



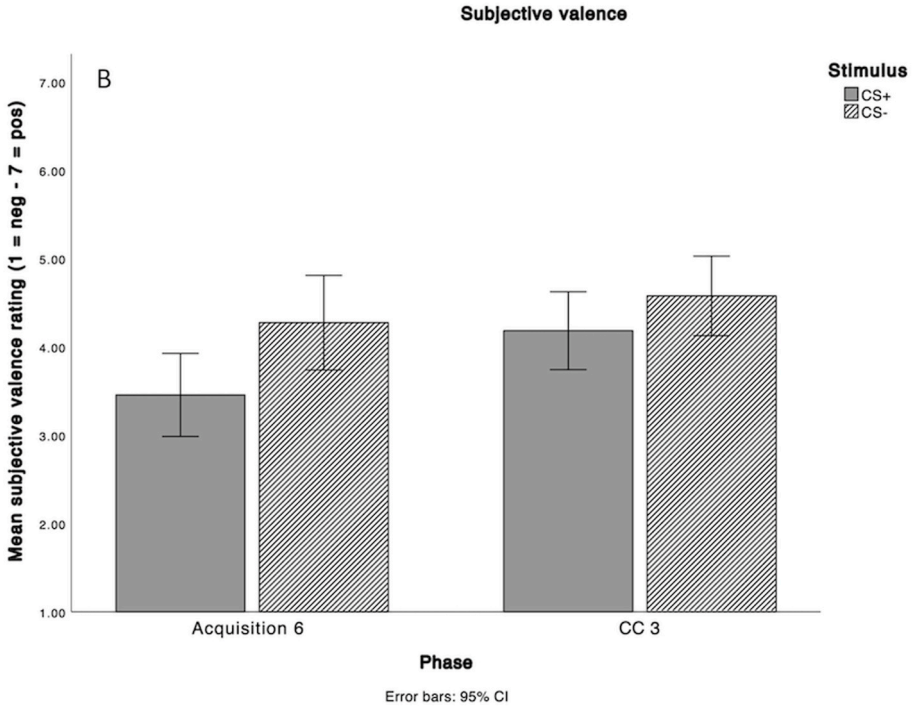


Fig. 7. Subjective valence ratings post-acquisition and post-extinction (panel A) and post-acquisition and post-CC (panel B).

p = .143. Post-extinction/CC participants expressed significantly stronger desire to watch the film clip including the CS- (M = 4.28, SD = 1.90) than the film clip including the CS+ (M = 3.65, SD = 1.86). A similar trend was evident with regard to participants' film clip preference ratings. The proportion of participants that preferred to watch the film clip including the CS + tended to be smaller (N = 29; 39%) than the proportion of participants that preferred to watch the CS- (N = 45; 61%) [z = 1.74, p = .081]. These proportions were similar in the extinction condition (CS-, N = 24, 60%; CS+, N = 16, 40%), and the CC condition (CS-, N = 21, 62%; CS+, N = 13, 38%).

4. Discussion

This study examined the effects of repeated pairing of a sexual stimulus (erotic clip) with a disgusting stimulus on female sexual responses, as well as the effectiveness of a subsequent extinction or CC procedure to counteract these conditioning effects. The differential disgust conditioning procedure used in the current study was effective in eliciting differential US expectancies. Following acquisition participants' expectancies of disgusting US outcomes were differentially increased for the CS+. In addition, following the conditioning procedure the sexual stimuli that were used as the CS + acquired disgust-eliciting properties. Importantly, pairing sexual stimuli with a disgusting US also

lowered the properties of the CS + to elicit sexual arousal on both the subjective and genital levels, and changed the valence of the CS+ from pleasant to unpleasant. Although pelvic floor muscle responses were heightened in response to the disgusting US compared to neutral US, no conditioning effects on pelvic floor muscle activity were observed. The conditioned expectancies of disgusting US outcomes were successfully extinguished following CS-only extinction and CC procedures, such that the CS+ and the CS- were eventually rated as equally likely to be followed by the disgusting US. In spite of the fact that disgust-eliciting properties of the CS + decreased post-extinction/CC, they remained differentially increased for the CS + compared with the CS-. Although post-extinction/CC genital arousal was no longer differentially decreased for the CS+, and the subjective sexual arousal responses to the CS + increased after extinction and CC procedures, subjective sexual arousal remained differentially decreased for the CS + compared to the CS-. Furthermore, the valence of the CS + increased (were rated as more pleasant) following both the CS-only extinction and CC procedure. Lastly, behavioral approach tendencies assessed after the extinction/CC procedure were weaker in response to the CS + than to the CS-.

4.1. Conditioning effects

The results of the current study extend earlier findings showing that pairing of a sexual stimulus with an aversive pain stimulus results in aversive classical conditioning of female sexual responding, and is associated with diminished genital and subjective sexual arousal responses to this stimulus (Both et al., 2008; Brom, Laan, Everaerd, Spinhoven, & Both, 2015). The current study has shown that such aversive conditioning effects are not restricted to sex-pain associations, but can also be elicited by learned sex-disgust associations. More specifically, the current study showed that the pairing of erotic stimuli with a strong disgust eliciting US can increase the negative emotion-eliciting properties of sexual stimuli and decrease sexual arousal responses as well as positive evaluations of sexual stimuli.

Previous research has shown that even a priori pleasant stimuli prompt the defensive system as soon as they acquire signal value for threatening outcomes (e.g., Bradley, Moulder, & Lang, 2005; Hamm, Greenwald, Bradley, & Lang, 1993). In line with this, the reduction in arousal eliciting properties of the CS + following acquisition might be explained by assuming that the defensive system temporarily overruled the appetitive system which would be habitually prompted under safe conditions (i.e., where sex stimuli do not predict aversive outcomes). This may also explain why the arousing properties returned following the extinction and CC procedures. Because following CC and CS-only extinction procedures the CS + lost its signal properties for the aversive disgusting outcome, the CS + no longer activated the defensive system, thereby removing its inhibitory influence on the appetitive system. A similar explanation could apply to previous findings in the context of pain conditioning of sexual stimuli. Earlier findings in the context of differential threat conditioning showed that the CS + not only acquires signal properties but also acquires a more negative affective valence that is relatively resistant to extinction (Hermans, Vansteenwegen, Crombet, Baeyens, & Eelen, 2002). Similar evaluative conditioning effects might have rendered the initially highly pleasant CS + less pleasant following acquisition. The repeated pairing with the disgusting US might have also resulted in referential associations that can explain the acquired disgusting properties of the CS + following acquisition. Since feelings of disgust have been shown to reduce sexual arousal (e.g., Borg et al., 2019), the acquired disgusting properties of the CS + might have also contributed to the reduction in sexual arousal following the CS + compared to the CS-. These findings further indicate that associative learning might be a viable pathway to develop disgust for sexual stimuli, and also support the view that negative experiences associated with sexually aversive situations, such as sexual assault, may result in decreased sexual arousal responses to sexual stimuli via classical conditioning, thus constituting a potential pathway for the development of sexual dysfunctions (Letourneau & O'Donohue, 1997; van Berlo & Ensink, 2000).

In contrast to our expectations, no conditioned pelvic floor muscle activity was observed. One explanation could be that the acquired disgust responses were too small to result in a reliable increase in pelvic floor activity during the presentation of the CS+. The sensitivity to find such effects was probably also reduced as a result of missing data (i.e., due to technical problems EMG data were not available for all participants). The intensity ratings of the disgust-eliciting US were high, with the majority of participants giving it the highest and second highest ratings of disgust. In other words, the disgusting US elicited a strong unconditional disgust response indicating that the absence of conditioned pelvic floor activity did not occur due to a lack of sufficient strength of the disgusting US. The finding that the pelvic floor activity was significantly greater in response to the disgusting compared to the neutral US provides further support to the notion that the disgusting US elicited an unconditional disgust response. Thus far, increased pelvic floor muscle activity has been observed in response to non-sexual and sexual threats (van der Velde et al., 2001). The current study is the first to show that pelvic floor reactivity may also be elicited by disgust. This finding is in line with the proposition that involuntary contraction of the pelvic floor muscles can be elicited by disgust-related appraisals as part of a general defense mechanism (e.g., de Jong et al., 2013).

4.2. 'Unlearning' of the conditioned responses

Corroborating findings from previous research (Engelhard et al., 2014), US expectancies decreased from post acquisition to post-extinction and post-counterconditioning. Following both procedures the CS+ and CS- no longer elicited differential US expectancies, indicating successful abolishment of the sex-disgust expectations that were acquired during the preceding conditioning phase. Nevertheless, both procedures were ineffective in eliminating conditioned disgust responses, corroborating previous findings that learned disgust associations are difficult to extinguish (Bosman et al., 2016; Olatunji et al., 2007). The finding that the CS-only extinction procedure was ineffective in modifying the conditioned affective responses is consistent with previous work showing that CS-only exposure is typically highly effective in modifying predictive associations but less so in modifying referential associations (e.g., Hermans et al., 2002). To correct this type of referential (instead of predictive) associations, new pairings of the CS + with strong positive stimuli seem more in place. The failure of the current CC procedure may have occurred due to the mild nature of the positive stimuli that were used in the current CC procedure. Indeed, the pleasantness ratings of the positive (CC) stimuli were generally lower than in earlier studies that found evidence for the efficacy of CC in modifying conditioned disgust responses (Engelhard et al., 2014; Lang et al., 1998).

As expected, the decrease in genital and subjective sexual arousal in response to the CS+ was successfully restored post-extinction and post-CC, providing evidence for the efficacy of both procedures in counteracting conditioned genital and subjective sexual responses. Thus, it appears that the reduction of learned disgust response following post-extinction/CC was large enough for the appetitive sexual arousal response to return as soon as the CS+ was no longer predictive of the aversive disgusting outcome. This finding could have treatment implications, as it suggests that following treatment one could return to sexual functioning despite some lingering disgust.

However, after both the extinction and CC procedures, the erotic clip that served as the CS + evoked less desire to watch than the clip that served as the CS-. This is consistent with the view that, once acquired, avoidance tendencies are difficult to break (cf. Pfaus, Kippin, & Centeno, 2001), which is in line with the predictions derived from the theories of sexual behavior (Hardy, 1964; Ågmo, 1999). Notably, the findings suggest that neither the extinction nor the CC appeared effective in eliminating the avoidance response toward the CS+. Thus,

participants not only showed relatively strong avoidance of the CS + after it was repeatedly presented in the absence of the disgusting US, but even after the CS+ was repeatedly paired with appetitive stimuli. Available evidence from animal studies indicates that the magnitude of sexual approach conditioning effects increases with the increasing sex-relevance of the CS (Cusato & Domjan, 2000, 2012; Domjan, Cusato, & Krause, 2004), suggesting that using sex-relevant appetitive stimuli as the CC stimuli may be more effective in breaking behavioral avoidance than using sex-irrelevant appetitive stimuli.

Furthermore, studies in both animals and humans have shown that administration of oxytocin can attenuate the effects of fear conditioning and facilitate extinction (Acheson et al., 2013; Campbell-Smith, Holmes, Lingawi, Panayi, & Westbrook, 2015; Eckstein et al., 2015; Petrovic, Kalisch, Singer, & Dolan, 2008; Toth, Neumann, & Slattery, 2012). Similarly, there are some indications that the use of D-Cycloserine can have an effect on learning and extinction in sexual contexts (Both, Van Veen, Brom, & Weijenborg, 2020; Brom, Laan, Everaerd, Spinhoven, Trimbos, et al., 2015). Lastly, studies on fear conditioning (Delgado, Nearing, LeDoux, & Phelps, 2008), evaluative conditioning (Gawronski, Mitchell, & Balas, 2015), and disgust conditioning (Olatunji, Berg, Cox, & Billingsley, 2017) in humans also showed that application of emotion regulation strategies, such as reappraisal (e.g., Olatunji et al., 2017), can attenuate conditioned fear response, decrease negative valence of the CS, and facilitate extinction, offering interesting avenues for future studies on strategies that might be helpful to reduce the impact of disgust conditioning on sexual responses.

4.3. Strengths, limitations, and recommendations for future research

The results of the present study indicate that when sexual stimuli repeatedly co-occur with feelings of disgust, these stimuli may be learned to signal disgust, acquire a negative valence, and become less competent in eliciting sexual arousal and sexual appetite. As noted before, this can occur, for example, in situations of sexual abuse, where sexual stimuli can co-occur with strong feelings of disgust toward the perpetrator, or under circumstances where individuals' own, or partner's appearance changes significantly (e.g., due to an illness) and elicits disgust. In these instances, individuals may become less easily sexually aroused due to the concurrent disgust eliciting properties of these stimuli (Borg et al., 2020). Such mechanism may also drive (or contribute to) problems of sexual aversion (Borg et al., 2020), and low sexual arousal (de Jong, van Lankveld, Elgersma, & Borg, 2010).

The current study provided first empirical evidence to support the notion of disgust conditioning as a possible pathway to low sexual arousal and sexual aversion. The results indicate that both extinction and CC procedures can be effective in counteracting disgust-conditioning induced reduction in sexual responsivity. However, the results also showed that not all conditioned responses were effectively counteracted. It has been well-documented that different components of emotional and sexual responses (e.g., genital arousal, subjective sexual arousal, affective valence, and behavioral approach) are not necessarily concordant (cf. Chivers, Seto, Lalumiere, Laan, & Grimbos, 2010). That is, for instance, women can experience vaginal lubrication, an element of the genital arousal response, in the absence of subjective feelings of liking and sexual arousal. Previous research indicated that diminished positive affect toward erotic stimuli following an aversive classical conditioning procedure is more resistant to extinction than diminished genital arousal responses, although also the positive affective responses to erotic stimuli can return after a more extensive series of extinction trials (Brom, Laan, Everaerd, Spinhoven, & Both, 2015). Perhaps, then, the relatively high number of acquisition trials compared to unreinforced (extinction and CC) trials in the current study (3:1) may help explain the limited effectiveness of the current procedures in extinguishing some of the acquired responses. Regrettably, the facial EMG measurements in the current study were hampered by technical difficulties; the use of facial EMG measures in future studies could be valuable for objectively gauging disgust. In addition, the power was insufficient for reliably finding small-sized effects between the two conditions. Thus, it can be that there were more robust, yet subtle differences that went undetected because the study allowed to reliably detect only medium-sized (or larger) effects. Furthermore, the current study was conducted with women with no reported sexual problems, under laboratory conditions, and therefore it remains to be seen whether similar effects can be observed outside the lab and in the context of non-experimentally learned disgust (e.g., in clinical populations with strong sex-disgust associations).

As the current experiment did not directly compare disgust conditioning with pain conditioning, it remains to be tested to what extent conditioning to painful US versus disgust US recruits different learning processes in the context of sexual responses. It would also be important for future research to examine the effects of stronger and sex-relevant CC stimuli, and to evaluate the impact of using a larger number of extinction trials on the effectiveness of extinction and CC procedures. Further, it would also be interesting to investigate if the effects of extinction and CC can be strengthened by oxytocin and d-Cycloserin administration (cf. Brom, Laan, Everaerd, Spinhoven, & Both, 2015), and to examine the efficacy of emotion-regulation training for sexual arousal up-regulation or disgust down-regulation as alternative means to counteract the effects of acquired sex-disgust associations (cf. Borg & van Overveld, 2015). It would also be relevant for future research to investigate generalization effects by presenting participants with novel sexual stimuli following acquisition and extinction phases, and to examine the strength and persistence of the disgust conditioning effects by including follow up assessments (cf. Bosman et al., 2016).

5. Conclusions

To conclude, the current study has demonstrated modulation of genital and subjective sexual responses, as well as modulation of affective responses in women using a disgust-conditioning paradigm. Overall, no evidence for differences in effectiveness of counteracting conditioned disgust responses was found between an extinction and a CC procedure. Both procedures appeared similarly effective in diminishing the conditioned subjective and genital sexual arousal responses. Yet, subjective disgust, and behavioral avoidance responses were shown to be resistant to both the extinction and the CC procedures. The current study constituted a first step toward understanding basic learning mechanisms as a candidate pathway to disgust-based sexual aversion, and points to the importance of further development of procedures that can fully counteract learned sex-disgust associations.

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Data statement

Research data for this project has been made available on EASY DANS platform (https://easy.dans.knaw.nl/) under the following https://doi.org/10.17026/dans-z4k-6n4w.

CRediT authorship contribution statement

Aleksandra Pawłowska: Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Charmaine Borg:** Conceptualization, Writing - review & editing. **Peter J. de Jong:** Conceptualization, Writing - review & editing. **Stephanie Both:** Conceptualization, Methodology, Resources, Writing - review & editing, Supervision, Project administration.

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